

A new Paraleptamphopidae (Crustacea Amphipoda) in the burrow of *Virilastacus rucapihuelensis* (Parastacidae) and surrounding peat bogs. *Rudolphia macrodactylus* n. gen., n. sp. from southern South America

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Abstract

A new genus and species of a Chilean Paraleptamphopidae is described. *Rudolphia* n. gen. shares eleven characters with the family diagnosis *sensu* Bousfield, 1983. The diagnosis of the new genus is: A1 and A2 long; A1 equal to length of body, A1 inner flagellum scale shaped, calceoli gammarid-type in males only; Mx1 asymmetrical; Gn1 propodus mitten-like, palmar index = 1.81; Gn2 carpus longer than Gn1, palmar index = 2.39; coxal gills: P2–5 and 7 bilobate, P6 ovoid; dactyls of pereopods very long; Pleopods multiarticulate, Pl 2 sexually dimorphic; Uropods birami, rami uniarticulate, Ur1 and Ur2 exopodites scarcely shorter than endopodites, Ur1 peduncle longer than rami, Ur2 resembling Ur1 but much shorter, Ur3 subequal in length to Ur2, Ur3 peduncle shorter than rami, rami acuminate of equal length, with pairs of a bifid and a plumose setae; Telson cleft halfway. *Rudolphia macrodactylus* n. sp. is the first discovery of Paraleptamphopidae sp. out of New Zealand. A cladistic analysis allows us support that Paraleptamphopidae clade was differentiated before the New Zealand–South America separation (80–85 mya).

Key words: Crustacea, Pholeteran, Phylogeny, Biogeography, Amphipoda, *Rudolphia macrodactylus* n. sp.

Resumen

Rudolphia macrodactylus n. gen., n. sp. es el primer Paraleptamphopidae descrito fuera de Nueva Zelanda. *Rudolphia* n. gen. comparte once caracteres de Paraleptamphopidae *sensu* Bousfield, 1983. La diagnosis del nuevo género comprende: ambas antenas largas, A1 de igual longitud que el cuerpo, flagelo interno de la A1 en forma de escama, calceoli de tipo gammarida solo en los machos, Mx1 asimétricas, propodo del Gn1 en forma de mitón, índice palmar = 1.81, carpo del Gn2 más largo que el Gn1, índice palmar = 2.39, branquias coxales P2–5 y 7 bilobuladas, branquia coxal P6 ovoide, dactilos muy largos, pleópodos multiarticulados, Pl 2 con dimorfismo sexual, urópodos biramosos, ramas uniarticuladas, exopoditos de los Ur1 y Ur2 algo más cortos que los endopoditos, pedúnculo del Ur1 más largo que la ramas, ambas ramas del Ur3 acuminadas de igual longitud con pares de setas, una bífida y otra plumosa, telson medianamente hendido. El análisis cladístico nos permite sostener que el clado Paraleptamphopidae se habría diferenciado antes de la separación de Nueva Zelanda y Sudamérica (80–85 ma.).

Palabras clave: Crustacea, Foletero, Filogenia, Biogeografía, Amphipoda, *Rudolphia macrodactylus* n. sp.

Introduction

The documented South American freshwater amphipod diversity is relatively scarce at the family, genus and species level (Väinölä *et al.*, 2008) including four groups: hyalellids, ingolfiellids, gammarids (*sensu lato*) and

corophiids (Williams, 1986; Peralta & Grosso, 2009). A new species was found in epigeal and hypogean habitats in southern Chile, being the first record of Paraleptamphopidae Bousfield, 1983 from South America. Prior to this discovery, Paraleptamphopidae have been thought endemic freshwater of New Zealand, including two genera *Paraleptamphopus* Stebbing, 1899 and *Ringanui* Fenwick, 2006. This family remained poorly understood or ignored (Williams, 1986; Bradbury & Williams, 1999) until Fenwick (2006) established *Ringanui* for two stygobites species from New Zealand. It was the first step in clarifying the family status but none cladistic analysis was elaborated until now.

A detailed comparison and a cladistic analysis including Paraleptamphopidae and other amphipods distributed on land-masses derived from gondwanan continent, allow us to establish a new genus: *Rudolphia* n. gen. for the Chilean species. *R. macrodactylus* n. gen., n. sp. spreads the distribution of Paraleptamphopidae across Antarctic continent like others transantarctic distributions of subterranean Amphipoda and Anaspidacea (Schminke, 1980; Grosso & Peralta, 1999, 2002; Grosso *et al.*, 2006). The distributional areas and the phylogenetic relationships of these groups with disjunct distributions, lead to a hypothetical reconstruction of the separation events of occidental Gondwana in Cretaceous times.

Some *Rudolphia macrodactylus* n. sp. specimens were collected in burrows of the Parastacidae *Virilastacus rucapihuelensis* Rudolph and Crandall, 2005. The incipient eyes reduction and unpigmented body of *R. macrodactylus* n. sp. would be signs of incomplete adaptation to hypogean habitats. The Paraleptamphopidae of New Zealand inhabiting alluvial aquifers and others epigeal-hypogean habitats like streams, pools and wells. These species are known to be widespread both geographically and ecologically on North and South Islands (Williams, 1986). The new Chilean species are the first record of a pholeteran amphipod in South America.

Methods

The specimens were stained in Chlorazol Black. Drawings were prepared using Leitz-Dialux camera lucida. One male was examined under Jeol-35 CF scanning electron microscopy.

The cladistic analysis was performed using TNT version 1.0 (Goloboff *et al.*, 2005). An heuristic search was carried out with 10 different replicates, each one with a different sequence of random additions to form the initial Wagner tree. Characters were considered as unweighted, and multistates as unordered. The group support was measured using relative Bremer Support (Goloboff & Farris, 2001).

Morphological and zoogeographical criteria were considered in order to select outgroups for the cladistic analysis of these and other genera. The matrix assembled included 8 taxa: *Rudolphia macrodactylus* n. sp., *Falklandella obtusa* Schellenberg 1930, *Praefalklandella cuspidata* Stock and Platvoet 1991, *Paraleptamphopus subterraneus* (Chilton, 1882), *Ringanui koonuiroa* Fenwick 2006, *Austrogammarus telsosetosus* Barnard and Williams 1995, *Pilbarus millsii* Bradbury and Williams 1997, and *Sternophysinx calceola* Holsinger 1992. A total 36 morphological characters were considered: 23 binary and 13 multistate (see Appendix 1–2).

Systematics

Rudolphia n. gen.

Both antennae (=A) long, A1 equal to length of body. A1 inner flagellum scale shaped. Calceoli gammarid-type, in males only. Maxille 1 (=Mx1) asymmetrical. Gnathopod 1 (=Gn1) propodus mitten-like, palmar index = 1.81. Gnathopod 2 (=Gn2) slender and longer than Gn1, palmar index = 2.39. Dactyls of pereopods (=P) very long. Coxal gills of P 2–5 and 7 bilobate; coxal gills P6 ovoid. Pleopods (=Pl) multiarticulate, Pl 2 sexually dimorphic. Uropods (=Ur) biramous, rami unarticulate, Ur1 and Ur2 exopodites scarcely shorter than endopodites. Ur1 peduncle longer than rami. Ur2 resembling Ur1 but much shorter. Ur3 subequal in

length to Ur2; Ur3 peduncle shorter than rami, rami acuminate of equal length, with pairs of a bifid and a plumose setae. Telson cleft halfway.

Type species: *Rudolphia macrodactylus* n. sp.

***Rudolphia macrodactylus* n. sp.**

(Figs. 1–5)

Material studied. Holotype male 5.34 mm. Allotype female 5.8 mm (Fig. 1a), Paratype female 6.1 mm.

Type locality: Rucapihuel, Prov. Osorno- X Región Chile. 40° 35' S 73° 34' W. In the water within burrows of *Virilastacus rucapihuelensis*, at 10 cm depth, 02/09/2002, Francisco Retamal and Erich Rudolph col.. Specimens deposited in the collection at Fundación Miguel Lillo (=FML), Argentina (Holotype FML 00980, Allotype FML 00981, Paratype FML 00982).

Additional material: 7 males, same date, collector, habitat and locality as type material (FML 00983); 15 females, 16 males and 8 immatures, from the water of a peat bog located 10 m from the type habitat, same collectors (FML 00984); 5 males and 4 females, from swampy terrain, same data as type material, E. Rudolph col. (FML 00985); 1 male, 1 female and 1 immature, from a peat bog, same data as type material, E. Rudolph col. (FML 00986).

Description of male Holotype: Body colorless, not very slender. Dorsum without conspicuous setae. Head subquadrate, anterior margin sinuous. Eyes reduced. Antennae very elongated. Gn1 shorter and more robust than second one. Pleonites deeper than peraeonites, coxal plates 1–4 deeper than 5–7. Pleonites with posteroventral angles acute and ventral margin naked. Urosomites free and shallower than the peraeonites. Telson excavated.

A1 (Fig. 1b; c), as long as body. Second article of peduncle as long as 3/4 of length of article 1 and twice as length of article 3. Outer flagellum with 29 articles, inner flagellum scale shaped with two terminal setae (Fig. 1c). First article of peduncle with strong, simple and plumose setae on distal inner surface, and 8 short stout aligned setae plus a pair of medial long, stout and plumose setae inserted behind the row on outer surface. Second article with similar setation as the article 1 and a dorsal medial groove holding a calceolus and two simple setae. Third article with two calceoli-setae complex groups, one dorsomedial with two setae, the other dorsodistal with three setae. Each outer flagellum article with 2–3 distal groups of simple setae, a dorsodistal calceolus on the 12 first articles, some of them with aesthetascs, the 17 distal articles with setae and every two articles with an aesthetasc, always smaller than calceoli. Calceolus morphology (Fig. 5a; b) of gammarid structural type (Lincoln & Hurley, 1981), of the simplest configuration: distal element conformed by 23–26 overlapping transverse plates; proximal element concave and low-cut on inner margin to the distal element; receptacle, bulla and stalk clearly configured.

A2 (Fig. 1d) nearly half of body length. Peduncle: articles 4–5 of equal length, both with terminal setae and a group of 2–3 setae halfway on ventral margin. Flagellum with 16 articles, all of them with dorso- and ventrodorsal groups of setae and calceoli on articles 1–10, decreasing in size.

Labrum (Fig. 1c) oval with scarce short setae on anterior margin.

Right mandible (=Md) (Fig. 1f) pars incisiva with 6 teeth, 4 short and blunt, 2 stout; lacinia mobilis strong, bicuspidate, with small denticles and one row of fine setae; diastema with 5 serrated setae; pars molaris elevated with oblong triturative surface, one half ridged and incompletely surrounded by denticles; palp triarticulated, medial segment longer than the others, with row of 4 large plumose setae on ventromedial margin, pointed terminal segment with 10 similar setae on ventral margin, a similar seta near articulation. Left Md (Fig. 1g) similar to right one, but with 6 serrate setae on diastema and 4 teeth on lacinia mobilis.

Labium (Fig. 1h) outer lobes convergent with acute mandibular lobes, inner lobes depressed.

Mx1 asymmetrical. Right Mx1 (Fig. 2a) inner lobe short, distal border oblique with 8 terminal plumose setae; external lobe with 12 setae, internal one pectinate, remaining denticulate. Palp uniform width, basal segment one third of distal segment length with 7 setae on tip: 5 stout and 2 slender; 2 thin setae near tip. Left Mx1 (Fig. 2b) similar to right one, but with 10 setae on external lobe and 6 slender setae on tip of palp.

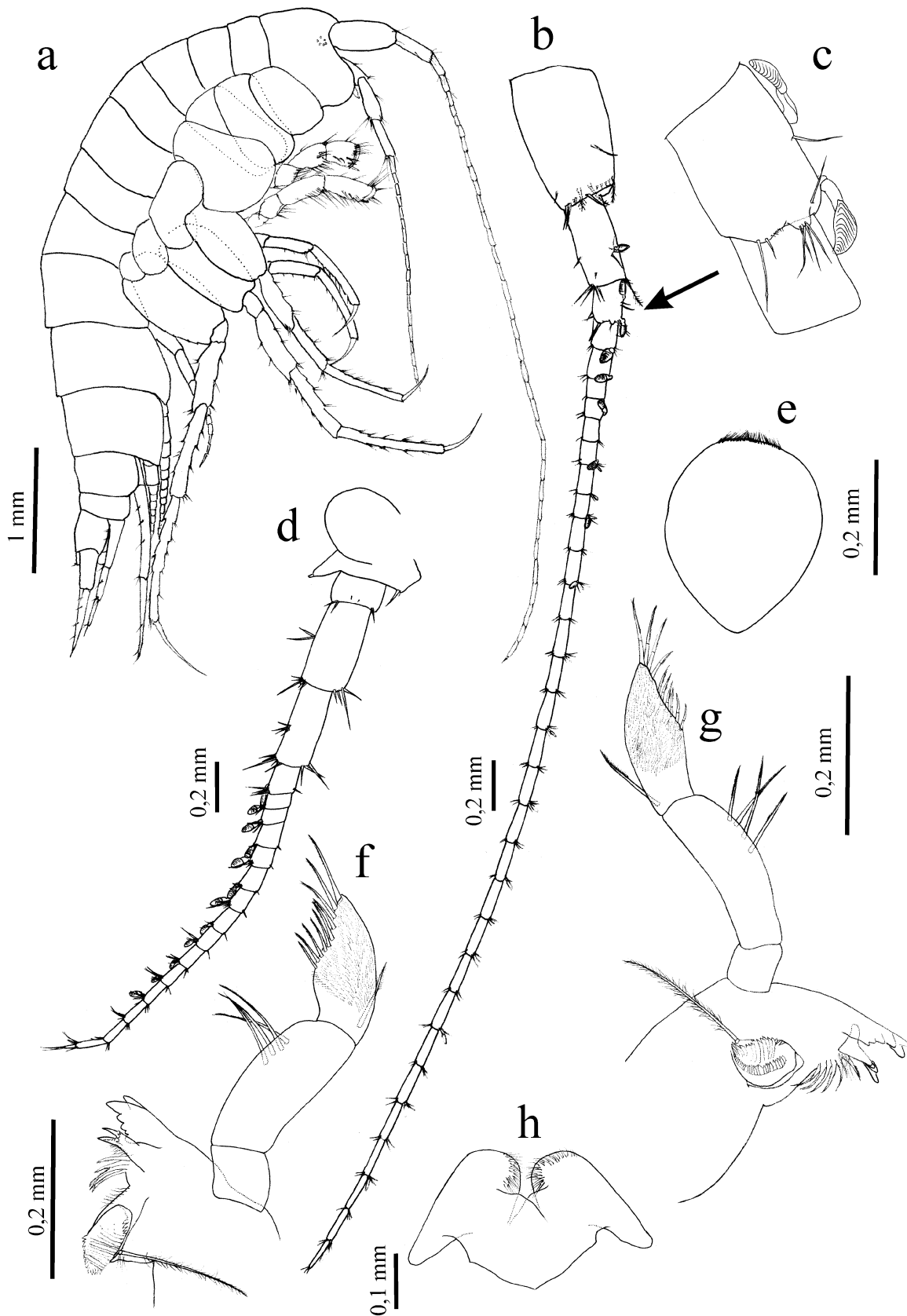


FIGURE 1. *Rudolphia macrodactylus* n. sp. a: Allotype female 5.8 mm, habitus. b–h: Holotype male. b: A1; c: A1 inner flagellum; d: A2; e: labrum; f: right Md; g: left Md; h: labium.



FIGURE 2. *Rudolphia macrodactylus* n. sp. Holotype male. a: right Mx1 ; b: left Mx1; c: Mx2; d: distal margin of inner lobe Mx2; e: Mxp; f: Gn1; g: Gn2. Scale= 0.1 mm.

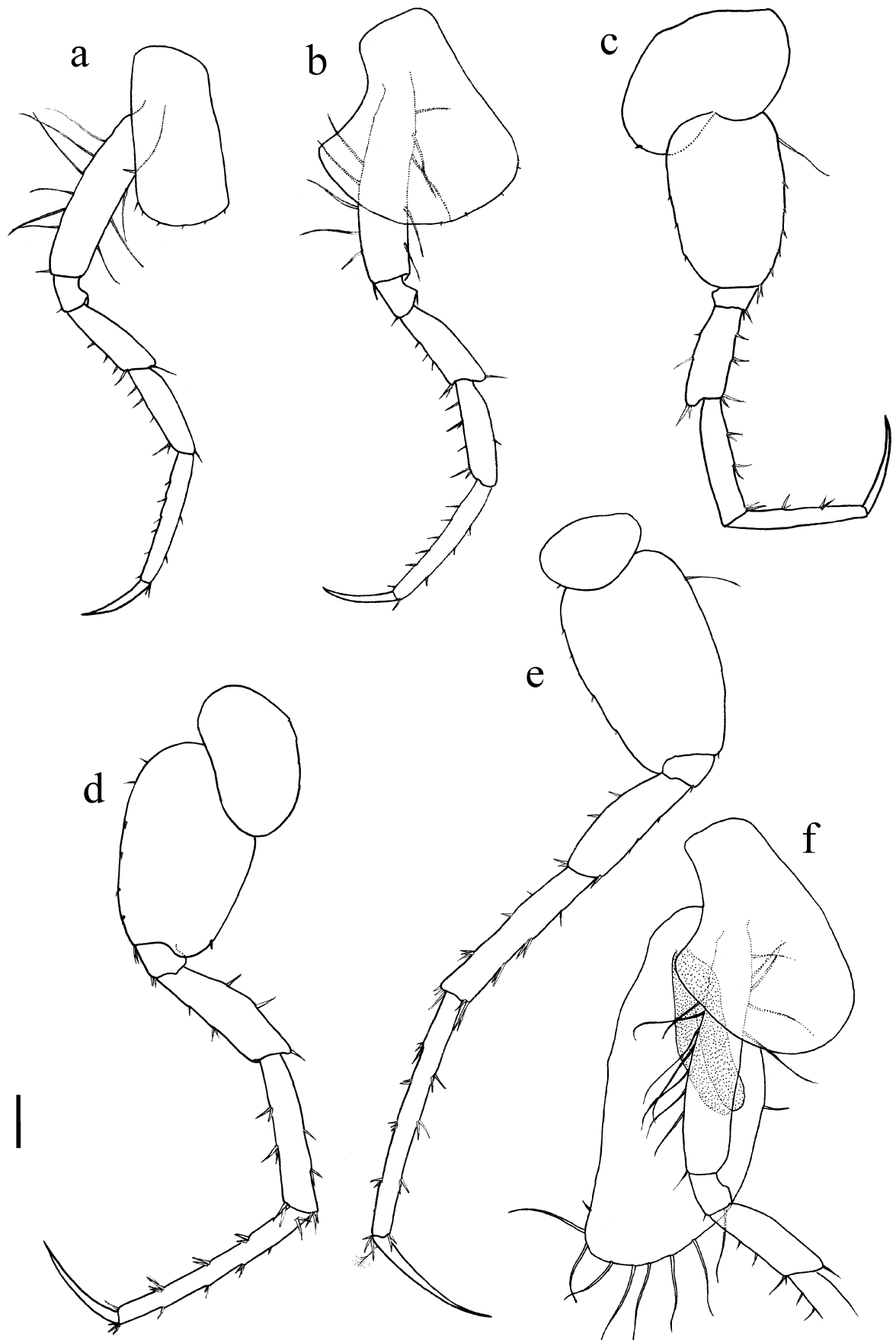


FIGURE 3. *Rudolphia macrodactylus* n. sp., a–e: Holotype male, peraeopods. a: P3; b: P4; c: P5; d: P6; e: P7. f: Paratype female, P4 with coxal gill and oostegite. Scale= 0.2 mm.

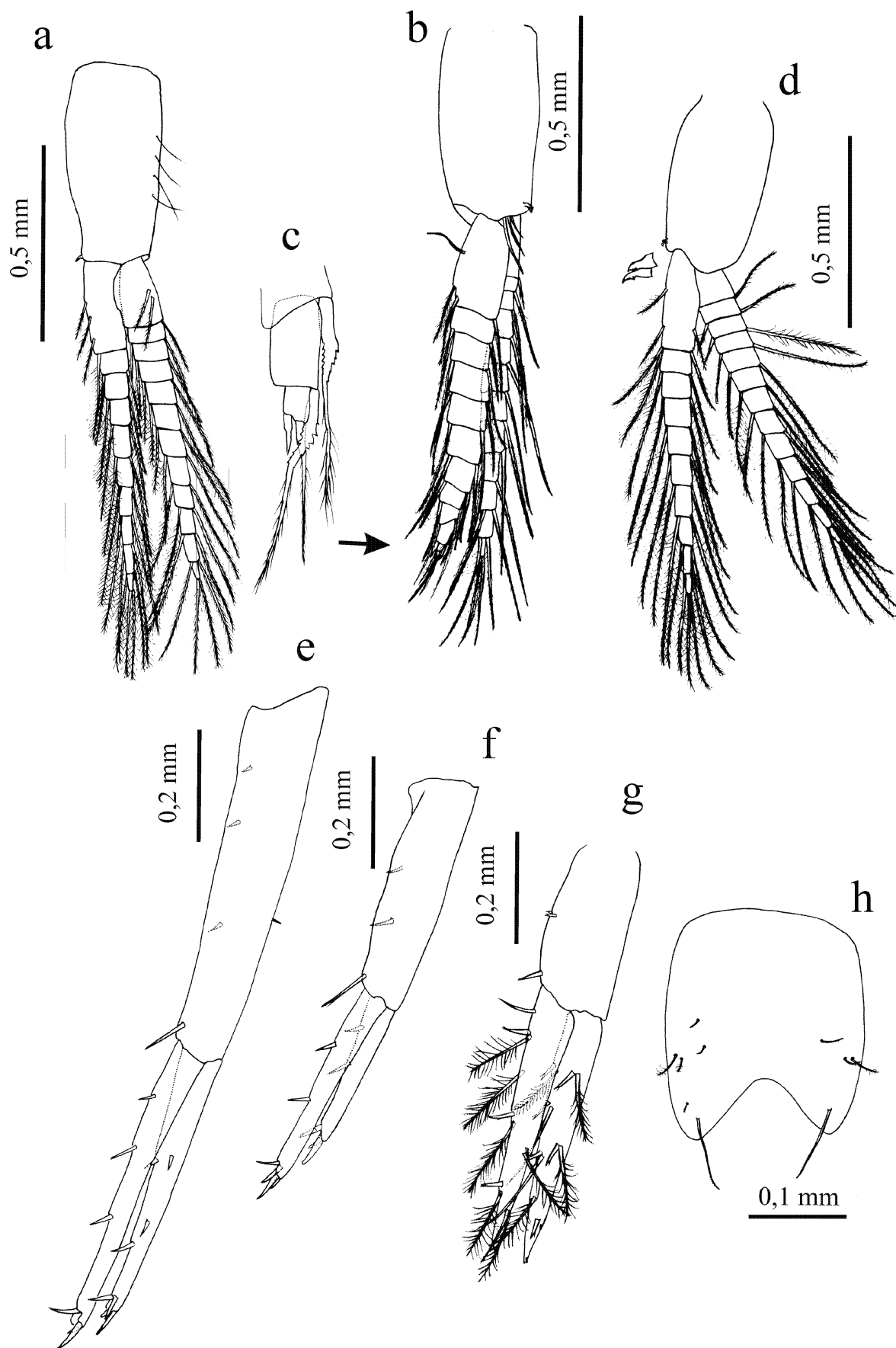


FIGURE 4. *Rudolphia macrodactylus* n. sp. Holotype male. a: Pl 1; b: Pl 2; c: Pl 2 last setae of exopodite; d: Pl 3; e: Ur1; f: Ur2; g: Ur3; h: Telson.

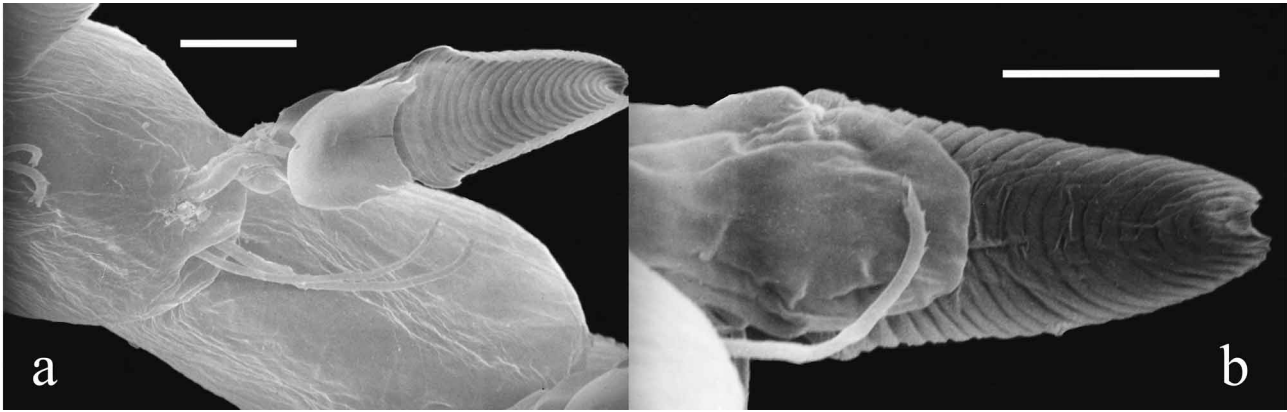


FIGURE 5. *Rudolphia macrodactylus* n. sp. male 5.2 mm. Scanning electron micrographs of calceoli on A1. a: concave surface; b: convex surface. Scale= 10 μ m.

Mx2 (Fig. 2c–d) inner lobe elliptic, scarcely shorter than external lobe, ventral surface crossed by oblique row of 9 long plumose setae, 5 fine setae along medial margin, with 3 rows of apical plumose or pectinate setae, one dorsal row of 4 setae, one terminal row of 8 setae and a ventral row of 14 setae. External lobe with 2 rows of pectinate setae, one dorsal with 7 setae and the other of 8 setae.

Maxilliped (=Mxp) (Fig. 2e) internal lobe reaching half of external one, with a row of 8 setae on internal surface, with 3 apical robust stout spines alternating with 3 fine pappose setae and a pair of fine external pappose setae. External lobe with 7 blunt setae on internal margin intercalated with 4 fine bifid setae, 4 apical serrate setae. Palp 4-articulated, with abundant setation on internal border, article 1 with 1 seta, article 2 with 25–26 plumodenticulate setae on entire internal border, 6–7 most proximal setae in a simple row and the remaining in a double row, article 3 with internal margin lobulated with 9 bifid plumodenticulated setae, internal face with 4 (3 aligned) bifid plumodenticulate setae. External margin with two groups of setae (4–3), an external one with 2 setae, 1 long simple and 1 bifid, and bipectinate; distal group with 4 bifid bipectinate setae, with small area with microsetae on distal angle. Dactylus small with a fine claw and 5 denticulate setae, external margin with microsetae.

Coxal plates (Fig. 1a): 1–4 deeper than wide with 4–5 spinules on ventral margin, plate 4 posteriorly excavated, plate 5 bilobate, plates 6 and 7 smaller, unilobate. Plates 3–7 with coxal gills, coxal gills 3–5, 7 bilobate, coxal gills 6 elliptic. Sternal gills absent.

Gn1 (Fig. 2f) coxal plate: posterior margin with only 1 seta bigger than the spinules of ventral margin; basis with 5 long setae on external face and 4 on internal one and 1 distoventral seta; ischium triangular with 1 distoventral seta; merus quadrangular with a rugose post-ventral lobe and 5 long bifid plumose setae; carpus with rugose posteroventral lobe, two groups of bifid plumose setae: proximally with 5 setae, distal with 7 setae and 3 similar setae on internal face; propodus mitten-like, palmar border flanked on both sides by 5–6 denticulated setae, with 3 bifid strong setae on palmar angle; 6 long setae on distodorsal angle, a group of 3 similar setae and oblique row of 3 setae on internal surface; posterior margin with 2 groups of 4 bipectinate setae. Palmar index (Ruffo, 1973) = 1.81.

Gn2 (Fig. 2g): slender and longer than Gn1 with similar spination, although propodus with rugose lobe and merus without them. Palmar index = 2.39.

Peraeopods (Fig. 3a–f): P3 and P4 similar, with 4–6 long setae on anterior and posterior margins of basis. P5–P7 increasing in length. Dactyls unusually long.

Pleopods (Fig. 4a–d) peduncles with 2 hooked retinacula, biramous, rami 10–12-segmented; peduncle of P1 1 with row of 4 fine setae. P1 2 with dimorphism consisting of modifications of 3 last setae of slightly wider exopodite (Fig. 4c) with oblique segmentation.

Uropods (Fig. 4e–g) biramous, rami uniarticulate, exopodites 1–2 scarcely shorter than endopodites, Ur3 rami of equal length. Ur1 peduncle longer than rami, with internal row of 4 setae, rami with 3–4 internal setae.

Ur2 resembling Ur1 but much shorter. Ur3 subequal in length of Ur2, peduncle shorter than rami, with two internal setae; rami of equal length, acuminate, with 4–5 pairs of setae, each one with a bifid shorter seta and a plumose seta inserted in a fossette.

Telson (Fig. 4h): cleft halfway with two lateral pairs of plumose setae, and a long bipectinate seta on each lobule, 4–5 tiny bifid setae on posterior half surface.

Description of Paratype female: Similar to male but with the following differences: A1 and A2 longer, without calceoli, A1 with 34 articles (29 in male) and A2 with 18 articles (16 in male), inner lobe of Mx1 with 10 terminal plumose setae (8 in male), exopodite P1 2 without modifications in the last 3 setae. Mature females with oostegites foliaceous with simple setae (Fig. 3f) on pereonites 2–4 and oostegite oval without setae on 5.

Both female specimens (5.8 mm and 6.1 mm) bigger than males (mean 4.74 mm).

Etymology: *Rudolphia macrodactylus* refers to the collector surname Erich Rudolph and the unusually length of the pereopods dactyls.

Remarks. Family status

Bousfield (1983: 273) provided a diagnosis of the *Paraleptamphopus* family group and included them within Eusiroidea. This author listed thirteen characters, only two of which differ from those of *Rudolphia* n. gen.: large inferior antennal sinus and plate-like coxal gills. Fenwick (2006) described a new genus, *Ringanui*, with two species, *R. koonuiroa* and *R. toonuiiti*, from South Island, New Zealand, and included them within Paraleptamphopidae.

Cladistic analysis. The result of the cladistic analysis was one most parsimonious tree (Fig. 6) with a score of 83.

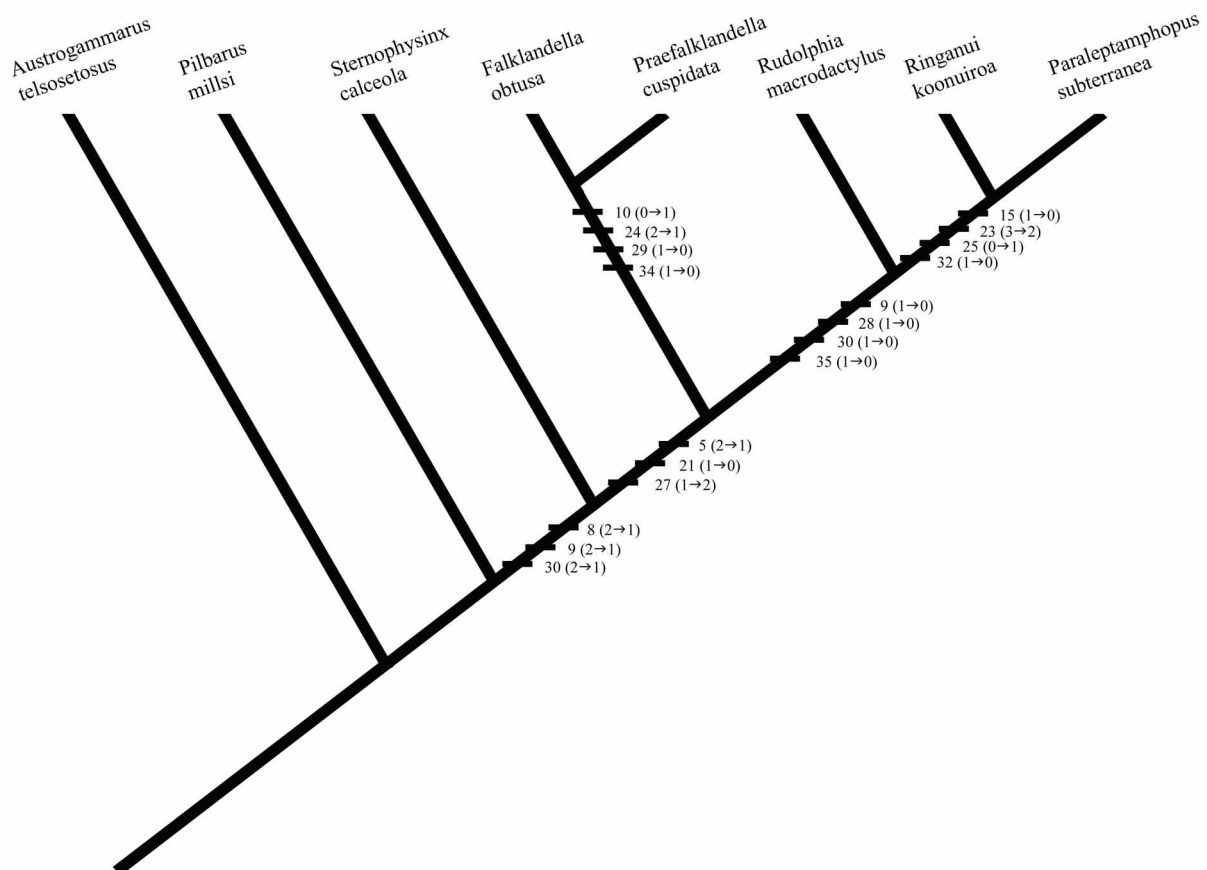


FIGURE 6. Most parsimonious cladogram from analysis of 36 morphological characters of 8 taxa: *Rudolphia macrodactylus*, *Falklandella obtusa*, *Praefalklandella cuspidata*, *Paraleptamphopus subterraneus*, *Ringanui koonuiroa*, *Austrogammarus telseosetosus*, *Pilbarus millsii*, and *Sternophysinx calceola*., with synapomorphies.

Discussion

According our analysis, *Rudolphia*, *Ringanui* and *Paraleptamphopus* are a monophyletic group (relative Bremer Support 10), supported by the unambiguous synapomorphies 9, 28, 30 and 35: Coxal plate 6 unilobate; Ur1 peduncle scarcely setose; Ur3 rami of equal length; and only one pair of subapical setae on telson. This group is the sister group of *Falklandella*+*Praefalklandella* (relative Bremer Support 71) because they share the unambiguous synapomorphies 5, 21 and 27: A1 inner flagellum with one article; Mxp with scarce ventromedial setae on article 2 of palp; and Ur2 longer than Ur3.

Characters of Paraleptamphopidae

Except for the *Falklandella*+*Praefalklandella* group, the remaining monophyletic groups are little or moderately supported. Despite this, we considered the inclusion of the new genus within Paraleptamphopidae because, in addition to the 4 synapomorphies (9, 28, 30, 35) of the *Rudolphia* + *Ringanui* + *Paraleptamphopus* group, the following characters were considered: eyes small or absent, cup-calceoli present on flagella of antennae, occasionally on peduncle of A1; mandibular left lacinia 4-dentate; gnathopods weakly sexually dimorphic and weakly amplexing; Gn1 usually the larger; pleopods moderately developed, not powerful; Ur1 and Ur2 lanceolate to sublinear; Ur3 rami lanceolate, weakly foliaceous or spinous; telson lobes fused to shallow apical V-notch; coxal gills usually present on P7; sternal gills lacking; brood plates large, broad, few small marginal setae.

Biogeographical considerations

The hypothesis of phylogenetic relationships obtained (Fig. 6) allow us to recognize a past geographical connection between southern South America and New Zealand, similar to the pattern shown by several other subterranean crustaceans (Schminke, 1980; Grosso & Peralta, 2002; Grosso *et al.*, 2006, Vonk & Schram, 2003; etc.).

The current distribution of Paraleptamphopidae is partially coincident with the distribution of the Amphipoda *Pseudoingolfiella* (Grosso *et al.*, 2006), *Paracorophium* (Fenwick, 2001), and the Anaspidacea *Stygocaris* (Noodt, 1963; Schminke, 1980; Grosso & Peralta, 1999) with respect to the geographical relationships between New Zealand and southern South America. This pattern become different from groundwater Isopoda Protojaniridae distributed on South America, South Africa and Sri Lanka (Grosso, 1992; Grosso & Quiroga, 2007). According our analysis, *Falklandella* and *Praefalklandella*, both from Malvinas Islands, would be “presumed to be an outlier of South Africa origin situated on an island group dragged across on the Fuegian tectonic plate away from earlier contiguity with Africa”, as presumed by Barnard and Barnard (1983: 57). The disjunction between AF+Malvinas Is. ↔ SA+ANT+KE+IN+AUS+NZ occurred during the early Cretaceous (130–120 mya), previously the disjunction of New Zealand from the remaining territories (85–80 mya) (Cooper, 1989; Hay *et al.*, 1999). Because the *Ringanui*+*Paraleptamphopus* (NZ) clade is more differentiated, the clade formed by *Rudolphia*(SA)+*Ringanui*+*Paraleptamphopus*(NZ) would have already been differentiated before New Zealand's isolation.

Acknowledgments

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Appendix 1. List of 37 characters used in the cladistic analysis with their respective states. Multistates characters were considered as unordered.

0. *A1 male, calceoli in peduncle and flagellum*. (0) absent; (1) present.
1. *A2 calceoli*. (0) absent; (1) in flagellum only; (2) in peduncle and flagellum.
2. *Calceoli*. (0) absent or present in only one sex; (1) present in both sexes.
3. *A1 length*. (0) short; (1) medium; (2) long.
4. *A2 length*. (0) short; (1) long.
5. *A1 inner flagellum*. (0) scale; (1) uniarticulate; (2) more than 1 article.
6. *Coxal plate 1–3*. (0) deeper than wide; (1) as long as wide.
7. *Coxal plate 4*. (0) small, not excavated; (1) large, excavated.
8. *Coxal plate 5*. (0) unilobate; (1) bilobate; (2) only anterior half lobate.
9. *Coxal plate 6*. (0) unilobate; (1) bilobate; (2) only anterior half lobate.
10. *Sternal gill*. (0) absent; (1) present.
11. *Coxal gills P2–5*. (0) ovoid; (1) bilobate.
12. *Coxal gills P6*. (0) ovoid; (1) bilobate.
13. *Coxal gill P7*. (0) absent; (1) present.
14. *Labium*. (0) with internal lobes; (1) without internal lobes.
15. *Mx1 inner lobe shape*. (0) oval; (1) triangulate; (2) elongate.
16. *Mx1 inner lobe, number of distal setae*. (0) few (2–4); (1) more than 8.
17. *Mx2 external lobe, number of setae*. (0) 7–9; (1) more than 10.
18. *Mx2 inner lobe, oblique row: number of setae*. (0) 0; (1) 6–7; (2) more than 8.
19. *Mx1 palp*. (0) symmetrical; (1) non symmetrical.
20. *Mx1 last segment of right palp, shape*. (0) expanded; (1) non expanded.
21. *Mxp article 2 of palp, number of ventromedial setae*. (0) 3–4; (1) 5–6; (2) more than 6.
22. *Mxp inner lobe shape*. (0) acuminate, short; (1) globoid, long.
23. *Mxp inner lobe, number of blunt distal setae*. (0) 2; (1) 3; (2) 4; (3) 5.
24. *Gn1 and Gn2 shape and size*. (0) both shape and size similar; (1) different shape; (2) similar shape but different size.
25. *Gn2 palmar margin*. (0) not very oblique; (1) very oblique.
26. *Gn2 rugose lobe in carpus and propodus*. (0) absent; (1) present.
27. *Ur1–3 length*. (0) $Ur2=Ur3$; (1) $Ur3>Ur2$; (2) $Ur2>Ur3$.
28. *Ur1 setae of peduncle*. (0) few; (1) many.
29. *Ur2 rami length*. (0) equal length; (1) not similar.
30. *Ur3 rami length and exopodite number of segments*. (0) equal length; (1) uniarticulate exopodite longer than endopodite; (2) biarticulate exopodite longer than endopodite.
31. *Ur3 shape of tip*. (0) acuminate, (1) not acuminate.
32. *Ur3 exopodite-peduncle length*. (0) both similar length; (1) exopodite longer than peduncle.
33. *Ur3 rami, type of setae*. (0) different type (plumose, bifid, simple); (1) only simple setae
34. *Telson shape*. (0) wider than long; (1) as long as wide.
35. *Telson number of subapical setae*. (0) one pair; (1) more than one pair.
36. *Telson*. (0) almost entire; (1) excavated less than 50%; (2) excavated 50%; (3) excavated 80%; (4) totally cleft.

Appendix 2. Morphological data matrix

| | | | 1 | | 2 | | 3 |
|--------------------------------------|-------|-------|-------|-------|--------|---------|---------|
| <i>Austrogammarus telsosetosus</i> | 010?? | 21122 | 10015 | 20001 | 12010 | 11112 | 10---11 |
| <i>Sternophysinx calceola</i> | 02100 | 20011 | 00001 | 01011 | 11111 | 00001 | -120411 |
| <i>Rudolphia macrodactylus</i> | 11010 | 01110 | 01113 | 20120 | 10010 | 01112 | 1001310 |
| <i>Falklandella obtusa</i> | 00010 | 11111 | 10000 | 10121 | 01[01] | 1111112 | 1001301 |
| <i>Praefalklandella cuspidata</i> | 11-21 | 11111 | 10010 | 10121 | 01011 | 11112 | 1001501 |
| <i>Ringanui koonuiroa</i> | 111-0 | 11110 | 00002 | 21020 | 10000 | 10001 | -001210 |
| <i>Pilbarus millsii</i> | 02020 | 21122 | 00004 | 20011 | 12011 | 02010 | 1011301 |
| <i>Paraleptamphopus subterraneus</i> | 11021 | 11000 | 00001 | 01000 | 10001 | 10-1- | -001210 |